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COMPARATIVE STUDY OF CONVENTIONAL RETAINING WALL AND MECHANICALLY STABILIZED EARTH WALL USING PLAXIS 2D

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Abstract: Mechanically Stabilized Earth (MSE) wall system is retention system used for highway design. In conventional system, cast in place concrete structure is used that cannot accommodate significant differential settlement especially with poor sub-grade condition. MSE wall systems are economical earth retaining structure which can tolerate more settlement over traditional retaining wall systems. The comparative study between MSE wall and conventional retaining wall is done using geotechnical software 'PLAXIS 2D'. The simulation models of conventional and MSE retaining walls subjected to conditions of no surcharge as well as variable surcharge both in at rest and active state are created and analyzed using Plaxis 2D software. The comparative study of models of both types is done by creating and studying total stress, effective stress, deformed shape, variation in stress at different point, shear force and bending moment. The performance of conventional and MSE wall is evaluated to identify their suitability for the purpose of retaining soil in location having differential settlement. The results obtained from simulation are also supported with manual calculation for the above said conditions. The aim of the study is to predict the behavior of both the type of retaining walls under different loading condition which will further help to choose the appropriate type of wall among the above two walls.

Keyword-MSE, CRE, PLAXIS2D.

I. INTRODUCTION

Retaining walls are the structures constructed to resist the active earth pressure exerted by backfill soil. These types of walls are used in supporting of embankments in plain as well as hilly areas. Different types of retaining walls have been used since ages such as gravity retaining walls made up of stone and brick masonry, cantilever retaining walls made up of RCC. Nowadays these walls are made of mechanically stabilized earth (MSE) backfill which is reinforced with geo-grid layers. The theoretical analysis of above types of walls deals with calculating the effective stresses, displacements etc. Numerical analysis involves FEM based approach for analysis in software program 'PLAXIS 2D'. Comparison of analysis of conventional and MSE retaining walls is to be done and interpretation of results to be carried out for prediction of performance of both.

II. AIM

In present work the conventional retaining walls and MSE walls are designed and analyzed for at rest and active condition having zero and variable surcharge using Plaxis 2D a FEM based computational tool to asses and evaluate deformations, stability in terms of maximum deflection, shear force and bending moments. For the above analysis 24 cases were studied having above said conditions.

III. OBJECTIVES

- To model MSE and conventional retaining wall using Plaxis2D.
- To analyze both the wall under static condition.
- To find maximum horizontal and vertical displacement.
- To compare deformation for both MSE and retaining wall.

IV. LITERARTURE

Title: Landslide Stabilization Using Soil Nail and MSE.
Journal: Journal of Geotechnical and Geo environmental Engineering, ASCE, February 2005. Authors: John P. Tuner and Wayne G. Jensen

In this study a land stabilization system using tiered soil nail wall and a MSE wall was instrumented and monitored to

evaluate overall performance facilitate comparison between design assumption and field observation .This project demonstrates the feasibility of utilizing soil nail walls for stabilization of active landslide extending the application of soil nailing beyond its traditional scope of stabilization of cut slopes or for potentially unstable slopes. Axial forces in soil nails inferred from strain gauge measurement demonstrate the design method based on current recommendation are adequate for design of soil nail walls used for slope stabilization. Site condition, design aspects and construction of soil nail and MSE walls are described. The above study concluded that soil nailing is available method for active landslides. The yield or tension loads were within design values.
Title: - Effects of soil properties and reinforcement length on MSE wall deformation.

Journal: Earth Retention conference ASCE 2010 Authors: Omer Bilgin And Hugh Kim
In this paper we have studied the effects of soil properties and reinforcement length on MSE wall. It is suggested that the minimum reinforcement length should be about 70% of the wall length. But in some cases due to existing site conditions and limited space behind wall it becomes difficult to provide required reinforcement length. It was found that the wall deformations increase as the reinforcement length decreases; hence the use of soils with more favorable properties should be practiced to reduce wall deformations. It was seen that the reinforcement length has most significant effect on wall displacement compared to wall settlements. The reinforced soil internal friction angle has significant effect on wall deformations. It was concluded that current design practice of MSE wall usually requires reinforcement length of 70% of wall height. The effect of the properties of soils involved in MSE walls on wall behavior has been investigated for varying reinforcement lengths.

Title: - Ground Shock Resistance of Mechanically Stabilized Earth Walls. Journal: Int.J.Geomech.2014
Authors: Christopher Y .Tuan, Ph .D, P.E

In this paper a simple analytical method has been developed that characterizes plane shock wave propagation through reinforced soil and the dynamic interaction between soil and the retaining wall panels. The shock wave attributable to an explosion in the backfill was modeled as a velocity boundary condition at a standoff distance from the wall. The exact solution to this problem was obtained using the Laplace transform method. Full scale explosive test data from 4.6 m high and 24 m wide reinforced soil walls were used to validate the analytical methodology. The accuracy of the analytical method has further been verified by finite element analysis. The method is adequate for the response analysis of MS embankment walls underground shock attributable to an explosion in the backfill.
It was concluded that the analytical model proposed in this study provides a simple method or predicting the dynamic interaction between reinforced soil and wall panels underground shock loading. The maximum Resistance of MSE wall depends on mainly on its energy absorbing capacity and rate o energy dissipation.

V. METHODOLOGY

Following are the different cases having varying parameters such as height of soil, loading conditions etc. considered for the analysis.

Table 1: Cases considered for analysis

SRNO	ACTIVE	REST	ACTIVE WITH SURCAHRGE 25KN/m2	ACTIVE WITH SURCAHRGE 50KN/m2	ACTIVE WITH SURCAHRGE 100KN/m2	REST WITH SURCAHRGE 25KN/m2	REST WITH SURCAHRGE 50KN/m2	REST WITH SURCAHRGE 100KN/m2
Height of soil retained in m	3	3	3	3	3	3	3	3
Height of soil retained In m	6	6	6	6	6	6	6	6
Height of soil retained in m	9	9	9	9	9	9	9	9

PLAXIS 2D:
The present chapter deals with the working procedure of the finite element computer program called PLAXIS 2D. Also this chapter deals with the numerical modeling of 6 meter MSE wall as well as conventional retaining wall of 6 meter using numerical method through finite element computer program Plaxis 2D.

Step 1. General Settings of MSE Wall

In this steps the selection of model whether the plain strain or axi symmetric is defined. The file name and element node of 15 nodes is selected. With default acceleration keeping earth gravity as 9.8 m/s^2 the geometry dimensions are taken for required length and width. Even the grid spacing and number of intervals are specified in this step. The time in seconds, force in KN and length in meter is adopted. The general settings tab is shown below.

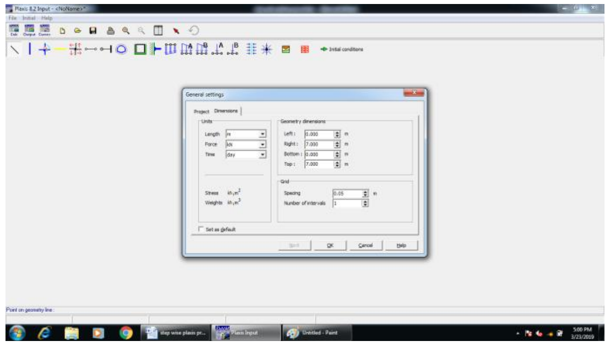

Figure 1 General settings

Step 2. Material settings of Wall

In this step the different material properties were selected. The properties for backfill soil, geogrid reinforcement and the plate is defined. The window gives the different soil phases in soil interphase lists and also gives the geogrid, plate and anchors in set type option. Even we can select these on the basis of model type and material type also. The following image shows the icon for material setting tab.

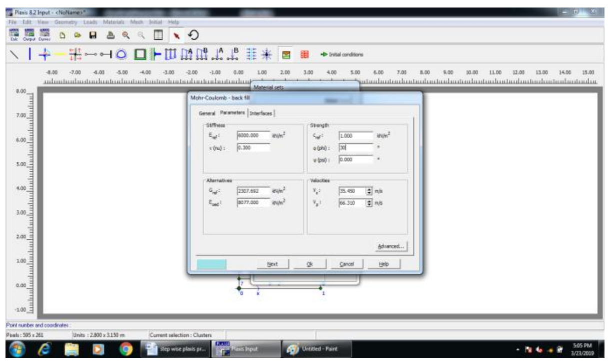

Figure 2 Properties for Backfill

Step 3. Mesh generation of Wall

This step deals with generation of modeled mall selecting the global coarseness as mesh generation because it gives good deformed mesh with lesser congestion. Also the deformation will be well visible without overlapping. The following figure shows the setup menu for mesh generation.

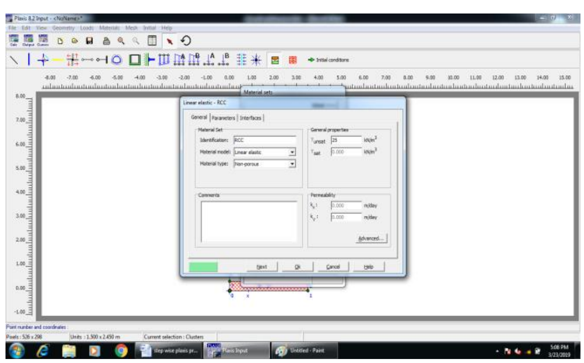

Figure 3 Properties of RCC

Step 4. Verification and Calculation

After the mesh generation the wall is left for pore pressure generation if water level is mentioned and also initial initial stresses are generated. After this the calculation is done for finding the deformations occurs in the wall under seismic condition. The calculation menu shows as below. In this menu the seismic file .SMC is selected to simulate the required earthquake to the model. The load multiplier is selected in the define menu and load multiplier is selected. The corrected acceleograms for different earthquake conditions are got from the USGS of USA. The typical example for one such acceleogram and calculation menu is shown below.

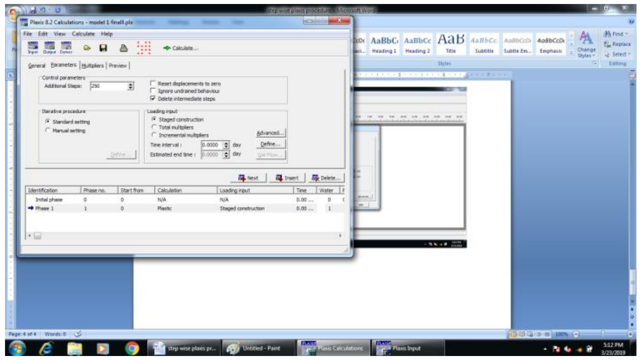

Figure 4 Output

Step 5. Output of the modeled wall

The resulted deformed mesh will be generated for each phased construction.

VI. ANALYSIS & RESULTS

Conventional retaining wall

Conventional retaining wall is modeled in plaxis for the parameter shown in table 2

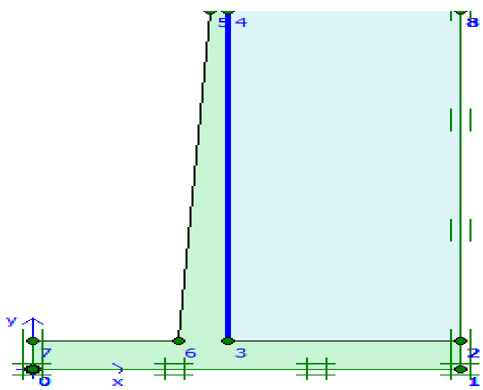

Figure 5 Model of Retaining wall

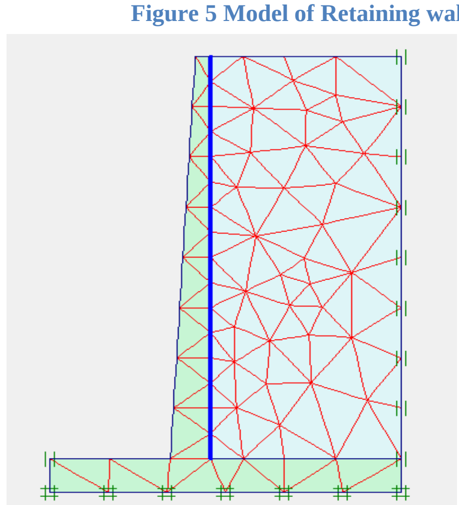

Figure 6 Mesh generated in PLAXIS

Mesh is generated in plaxis by dividing the wall in number of elements before the analysis.

Table 2 Components of Retaining Wall

Component	Length (M)
Total Height Of Retaining Wall	5.1
Width Of Base Slab	3.5
Thickness Of Base Slab	0.4
Toe Projection	1.2
Heel Projection	1.9
Stem Top Width	0.15
Stem Bottom Width	0.4

Loading is assigned in the form of soil pressure on the wall to get the results in the parameters like displacement, stress etc;

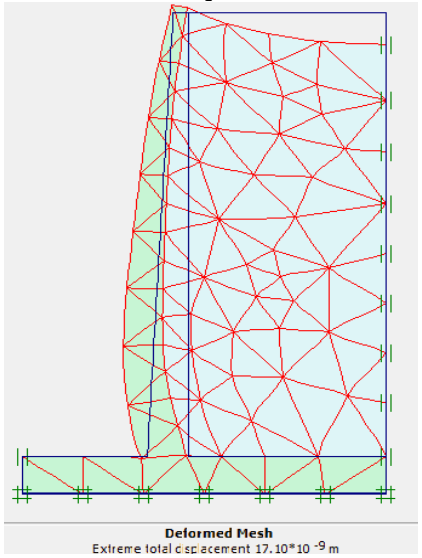

Figure 7 Deformed mesh

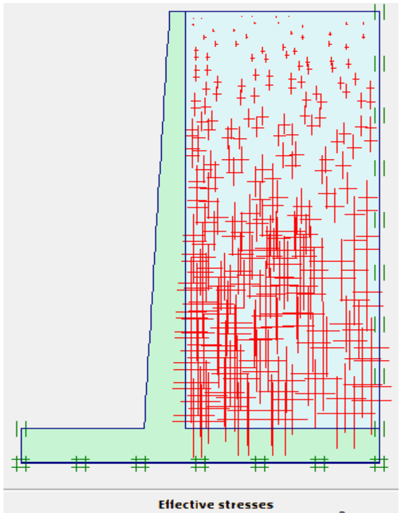

Figure 5 Effective stresses

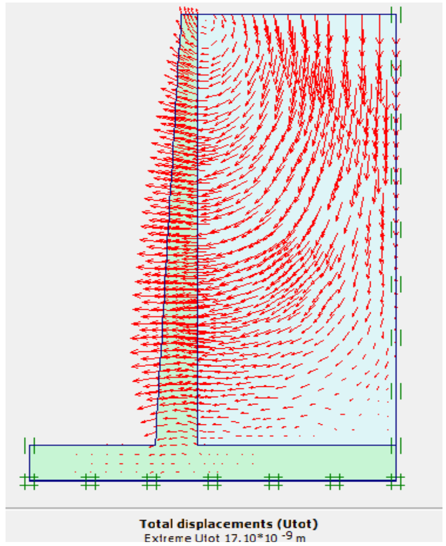

Figure 8 Total displacemet

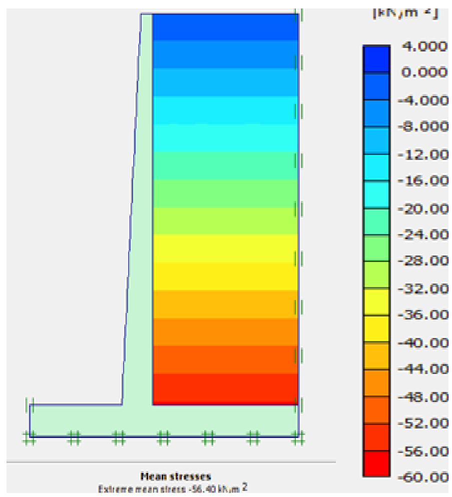

Figure 9 Mean stresses

The above figures shows the results of analysis of conventional retaining wall in PLAXIS 2D. The similar results were obtained for other cases specified in **Table 2.**

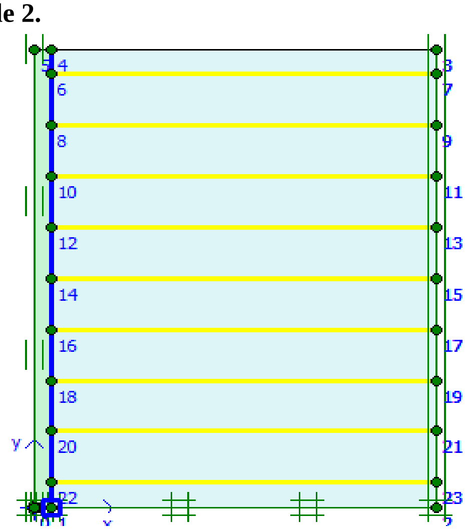

Figure 10 MSE wall in PLAXIS 2D

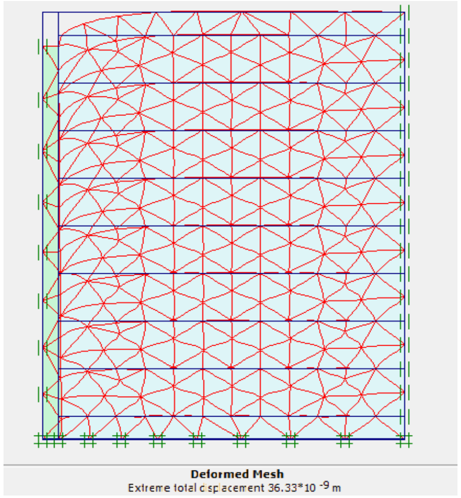

Figure 11 Mesh Generation of MSE wall

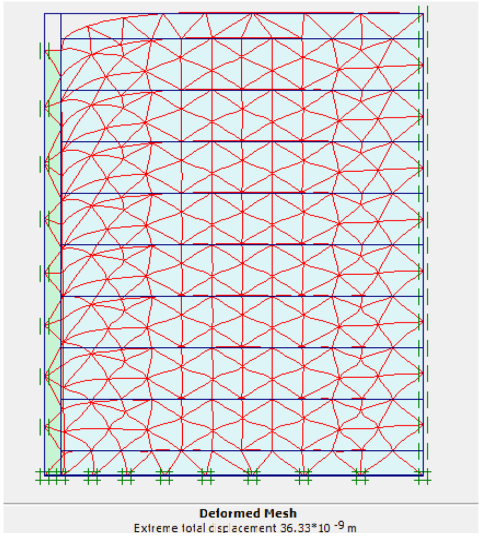

Figure 12 Deformed mesh of MSE wall

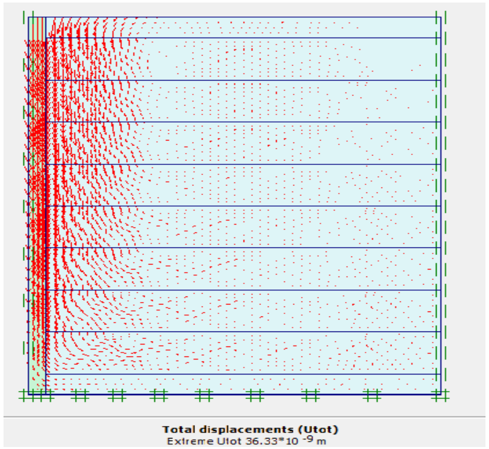

Figure 13 Total displacement of MSE wall

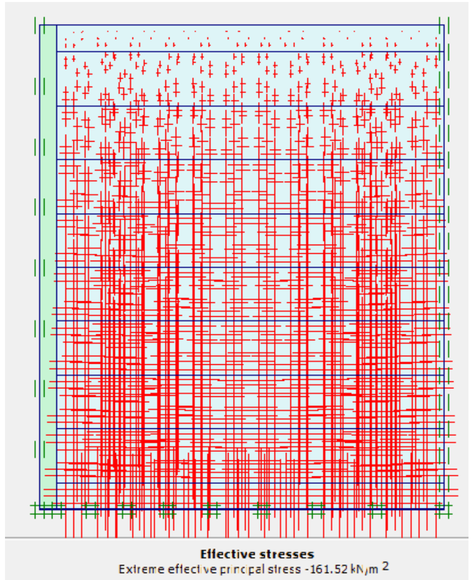

Figure 14 Effective stresses in MSE Walls

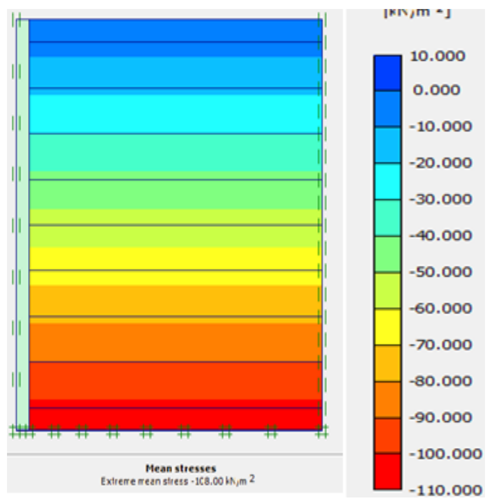

Figure 15 Mean stresses in MSE wall

The above figures shows the results of analysis of MSE wall in PLAXIS 2D. The similar results were obtained for other cases specified in **Table 2.**

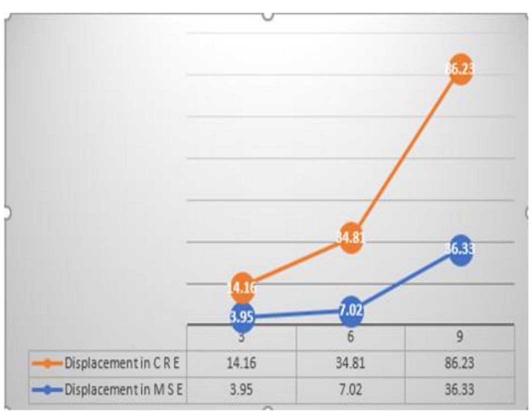

Figure 16 Displacement comparison

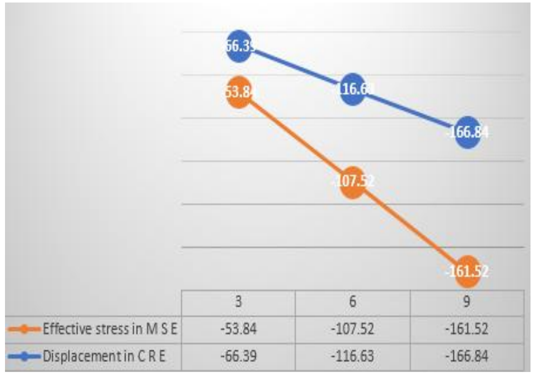

Figure 17 Effective stress comparison

In the figure it can be observed that the displacement in MSE wall is reduced as compared with the CRE wall.

VII. CONCLUSIONS

The comparative study of MSE and CRE wall is done using Plaxis2D and conclusions are made as follows:

1. The displacement in MSE wall is reduced by 57.86% for 9m height wall, 79.83% for 6m height wall, 72.10% for 3m height wall.
2. The stress in MSE wall is increased by 3.188% for 3m height wall, 7.811% for 6m height wall, 18.903% for 9m height of wall.
2. Stress comparison shows MSE wall gives maximum stress as compared with the CRE wall for 3m,6m And 9m height wall.
3. Analysis of CRE and MSE wall is done properly in Plaxis2D.

VIII. REFERENCES

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